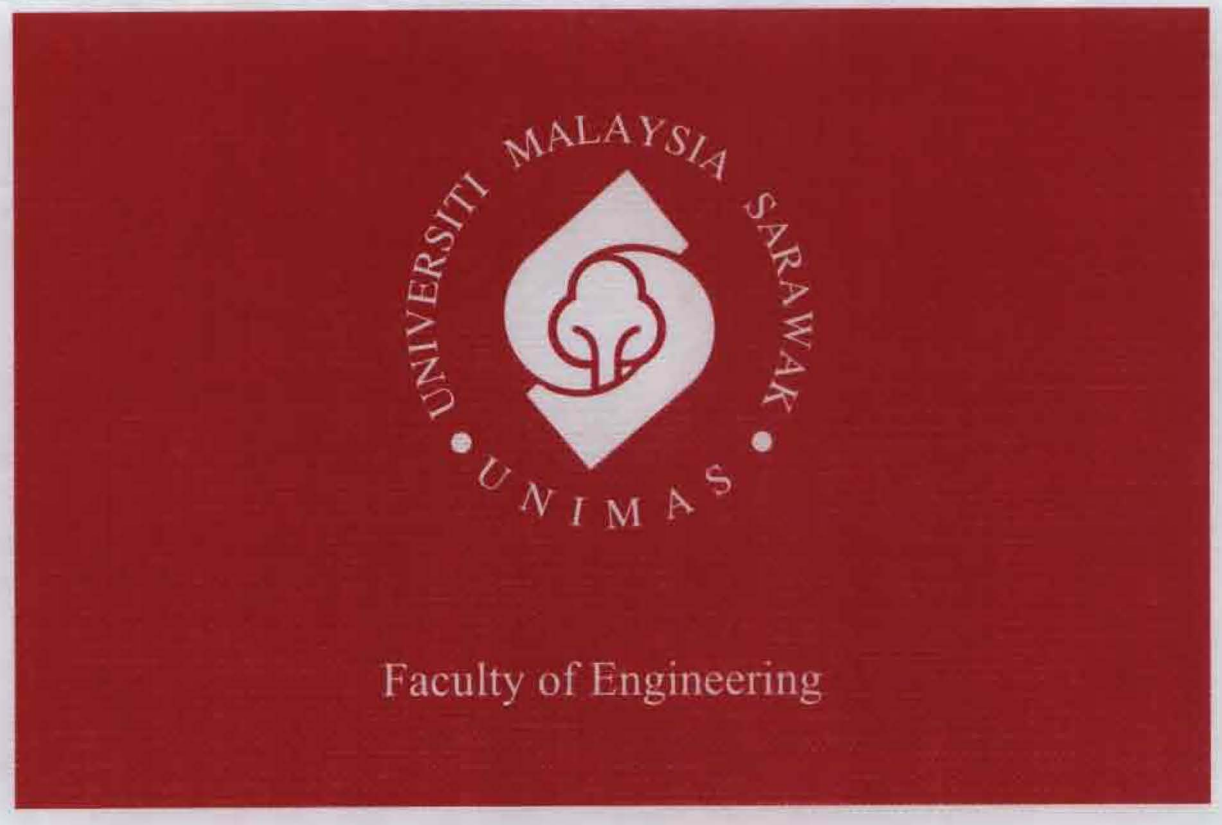

THE INVESTIGATION OF VITAL PHYSICAL AND COMBUSTION PROPERTIES FOR A RANGE OF BLENDS OF ETHANOL AND GASOLINE

Sherena Bt Sar-ee

Bachelor of Engineering with Honours
(Chemical Engineering)
2013

SIA SARAWAK

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Final Year Project Report	√
Masters	
PhD	

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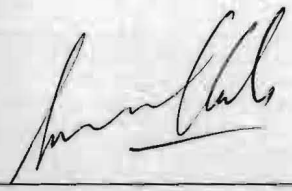

May 8, 2013

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Date :

THE INVESTIGATION OF VITAL PHYSICAL AND COMBUSTION PROPERTIES FOR A RANGE OF BLENDS OF ETHANOL AND GASOLINE

SHERENA BT SAR-EE

Thesis is submitted to
Faculty of Engineering, Universiti Malaysia Sarawak
In Partial Fulfilment of the Requirements
for the Degree of Bachelor of Engineering
Chemical Engineering (With Honours)
2013

This thesis is dedicated to my late grandmother for her everlasting love, my beloved parents, who always bestow me sustainable motivations and encouragements

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ABSTRAK

Saban hari kehendak dan keperluan terhadap tenaga meningkat seantero dunia. Tambahan lagi, masalah pencemaran alam sekitar kian meningkat. Hal ini menyebabkan, bilangan kajian dan penyelidik mengenai bahan api alternatif juga meningkat. (Le et al, 2011). Di Malaysia, pengeluaran etanol boleh diterokai dan diperluaskan terutamanya dalam bidang pertanian, sekaligus memberi peluang dan potensi kepada negara untuk meningkatkan ekonomi. Kajian ini berkisar tentang sifat fizik dan pembakaran pelbagai campuran etanol dan petrol. Terdapat 11 campuran bahan api iaitu E10, E20, E30, E40, E50, E60, E70, E80 dan E90. Manakala, E0 iaitu petrol asli dan E100 iaitu etanol asli juga disediakan. Antara sifat fizikal yang dikaji, ketumpatan, graviti tentu, nilai kalori, ketumpatan tenaga, kelikatan dan rintangan haba pelbagai komponen campuran telah disiasat. Sebanyak empat eksperimen telah dijalankan dengan mengunakan *Portable Density Meter*, *Thermogravinometry* and Differential Temperature Analyser *(TGA-DTA), Consistometer* dan juga Kalorimeter bom. Sepanjang kajian ini, sesetengah daripada campuran bahan api etanol dan petrol telah membuktikan bahawa penambahan etanol dalam bahan api berpotensi tinggi untuk menjadi sumber tenaga yang boleh diperbaharui. Nisbah campuran yang paling optimum adalah E20 di mana nisbah tersebut mempunyai ciri fizikal dan pembakaran yang hampir sama dengan petrol. Setelah melalui empat siri penyelidikan dan analisa, campuran petrol dan etanol sebagai sumber boleh diperbaharui dijangka mempunyai masa depan yang cerah kerana sifat fizikal dan pembakarannya yang boleh dipercayai.

ABSTRACT

The increasing of global energy demand and stringent pollution regulations have promoted research on alternative fuels (Le et al, 2011). The production of ethanol can be enlarged in Malaysia national agriculture and might boost the Malaysian Economy. Physico-combustion properties of various gasoline ethanol blends were evaluated. There are 11 blends which are E10 E20, E30, E40, E50, E60, E70, E80, E90 and E100 as well as pure gasoline known as E0. The density, specific gravity, calorific value, energy density ,viscosity and thermal resistance of various components of the blends were investigated. This experiment applied a Portable Density Meter, Thermogravinometry Analysis (TGA), Consistometer and Bomb Calorimeter. Throughout this study, ethanol gasoline blends fuel has proved that the addition of ethanol in the fuels has the highest potential to become a renewable energy source. The optimum blend ratio is E20 where it has almost similar physical properties of gasoline. After going through a series of experiments and research, ethanol gasoline blends as renewable source has bright future due to its dependable physical and combustion properties.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
DTA	-	Differential Thermal Analysis
HHV	-	High Heating Value
LEL	-	Lower Explosive Limit
MSDS	-	Material Safety Data Sheet
RFQ	-	Reformulated Gasoline
RON	-	Research Octane Number
TGA	-	Thermo-gravimetric Analysis
UEL	-	Upper Explosive Limit
US	-	United States
VOCs	-	Volatile Organic Compounds

CHAPTER 1

INTRODUCTION

1.1 General Overview

The world in the 21st century presents many critical challenges. The increase in energy demand, environmental concern of the global warming, climate change and increasing petroleum price in the worldwide has greatly increased the interests of the application study of the use of alternative fuels (M. Al-Hassana, H. Mujafeta and M. Al-Shannagb, 2012). From figure 1.1, the graph shows the rate of world population and oil production, whereas the rate of world population increases as the oil production increase.

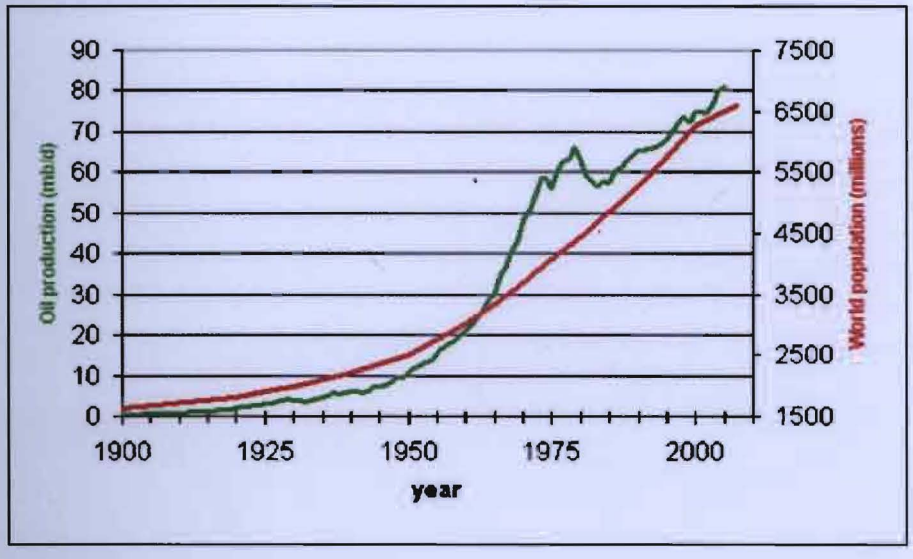

Figure 1.1: Rate of world population and oil production (Chefurka, 2007)

As global main energy resources, fossil fuel which comprises of coal, oil and natural gas are 80 to 90 percent of total energy resources. Meanwhile the remaining 10 to 20 percent of energy resources are supplied by nuclear and renewable energy (Wohlgemuth and Missfeldt, 2000; Asif and Muneer, 2007). The prices of petroleum products are generally on an increasing trend and consequently affecting the general cost of living. Besides that, the most critical challenges are the environment. As world population increases and the standard of living improve, there is a growing concern that there will be a shortage of energy for homes, vehicles which human need the most. Advances in technology have the allowed development of alternative energy sources. Alternative energy sources are renewable, cleaner, and more dependable than traditional fuels. The consumption of petroleum products also has other inconveniences such as environmental pollution and the emission of greenhouse gasses generally believed to be responsible for global warming (Tangka J.K *et al*, 2011)

The general trend all over the world has now been to reduce the over dependence on petroleum products so as to help reduce the effects of global warming. Other possible advantages of abandoning petroleum products is the fact that alternative sources can be produced from renewable resources that are available almost everywhere that there is life. This avoids the employment of heavy infrastructure for long distance transportation and distribution. The need for alternative sources of energy especially those that can be produced and utilized in enclave areas cannot be over emphasized. Amongst the various alternatives that are attracting attention today, is the use of ethanol as fuel for the motor vehicle engine (Tangka J.K et al, 2011).

1.2 Background of Study

Since the late 1970s ethanol has been added to gasoline. Since that time the United States (U.S) fuel grade ethanol production capacity has grown over 12 billion gallons per year and production volumes continue to increase. Until the late 1980s ethanol's primary role in the fuel production was that of an octane enhancer and it was viewed as an environmentally sound alternative to the use of lead in gasoline. With its 112.5 blending octane, ethanol continues to be one of the most economic octane enhancers available to the refiner or fuel blender. After that, by 1980's some states began to use ethanol and other oxygenates in mandatory oxygenated fuel programs to reduce the emissions of carbon monoxide (CO). The success of these early oxygenated fuel programs led to a similar national program in the 1990 Clean Air Act Amendments (Renewable Fuels Association, 2011)

At the beginning of January 1995, the 1990 Clean Air Act Amendments also required that certain ozone non-attainment areas sell reformulated Gasoline (RFQ). Then recently, in 2009 reformulated gasoline comprised 34% of all gasoline sold. The purpose of RFQ program is to reduce automobile emissions of volatile organic compounds (VOCs) and Oxides of Nitrogen (NOx) which are ozone precursors. The program also designed to reduce toxic emissions (Renewable Fuels Association, 2011).

Overall, based on the RFQ requirements, a great majority of the renewable fuel will be produced with feedstocks other than corn and row crops, further improving the already positive carbon footprint of corn based ethanol. The ethanol industry will

expand its production to meet RFQ requirements. In fact, in the late 2010 over 88% of the gasoline sold in the U.S already contained ethanol (Jim Jordan, 2010).

Nowadays in Malaysia the automotive industry is expanding as well as the increasing of fuel's price in the market. In order to overcome this problem, oversees development of alternative fuel use of alternative fuel become broad, but in Malaysia this area is still limited (Abdul Hadi, 2010). This research focuses on ethanol gasoline blends or commonly known as gasohol. The investigation of vital physical and combustion properties for a range of ethanol and gasoline will be gathering data in Malaysian environment is useful to give some insight to estimate the usefulness of Ethanol blends as compared to Gasoline or other equivalent fuels.

1.3 Problem Statement

The demand for energy is increasing day by day. On the other hand, fossil fuel resources are exhaustible and expected to be depleted in the next 30 to 80 years (Gevorkian, 2006). Therefore, corresponding to the decreasing amount of energy resources, a number of researchers and studies have been conducted to find alternative energy of the future in which it should be more environmentally friendly and sustainable. Consequently, the blends of ethanol and gasoline have high potential and started since the late 1970s.

Since that time U.S fuel grade ethanol production capacity has grown to over 12 billion gallons per year and production volumes continue to increase (Renewable Fuels Association, 2011). Regardless of the blend level, the quality of the ethanol

added to gasoline is important. This study will be focus on the physical and chemical properties of the blends of ethanol and gasoline by measuring different ratio of fuels.

1.4 Objective

The main objective of this project is to study to investigate vital physical and combustion properties for a range of blends of ethanol and gasoline for instance starting from E10 (10% Ethanol & 90% Gasoline) and go up to E100.

1.5 Research Methodology

In order to achieve the objectives as mentioned in Section 1.4, the study has been divided into a few stages as follows:

i. Stage 1 : Literature review

Information on ethanol and gasoline are collected at this stage. Previous studies on the blends of ethanol and gasoline at different range also reviewed in these stages. The review focuses on vital physical properties, chemical properties and investigates previous research done by using a different range of ethanol gasoline and also different types of blends.

ii. Stage 2 : The blend of gasoline and ethanol

Material for the experiment will be prepared. In this study, the ethanol and gasoline will be prepared and then blend together according to the ratio or range state below. Besides that, before set up any experiment, the Material Safety Data Sheet (MSDS), physical and chemical properties for each material need to be prepared.

Table 1: Sample code table

Sample code	% Ethanol	% Gasoline
E10	10	90
E20	20	80
E30	30	70
E40	40	60
E50	50	50
E60	60	40
E70	70	30
E80	80	20
E90	90	10

iii. Stage 3 : Set up an experiment

After identifying the physical and chemical properties, an experiment should be set up by measuring all the criteria using different equipment in the laboratory. The procedure and criteria which are adopted from previous study are then willing be interprets and analyses.

iv. Stage 4 : Data collection

Data collection will be done experimentally or by using the previous research collection.

v. Stage 6 : results and discussions

The results are examined and discussed in detail. The results are depicted in the form of tables, graphs, comparisons and detail discussion on the advantages and disadvantages are made.

1.6 Expected outcome

Since the study is conducted to analyze vital physical and combustion properties for a range of blends of Ethanol & Gasoline. The study is expected to provide discussion on the physical and combustion properties which explained about the

characteristic for each property and its impact on the mixture of different range of the fuel consumption.

Besides that, it is vital to find out the salient properties of both physical and combustion natures for a range of blends, for instance starting from E10 (10% Ethanol & 90% Gasoline) and go up to E80 and further. The major physical properties can be viscosity, vapor pressure and the combustion properties can be flash point, energy content and much more. Data in Malaysian environment is useful to give some insight to estimate the usefulness of Ethanol blends as compared to Gasoline or other equivalent fuels. Furthermore, it is important to take into consideration about the Malaysia economic, environmental and social impacts about the blends of ethanol and gasoline mixture.

1.7 Summary

This chapter generally discusses the importance of alternative energy in order to confront global energy challenges which are the depletion of fossil fuel and their impacts towards the environment. Besides that, the ethanol based fuel provides a renewable fuel choice and the use of ethanol can reduce our dependence upon oil and most importantly reduce greenhouse gas emissions. Therefore, this study aims to determine the vital physical and combustion properties for different range of ethanol and gasoline a substitute for fossil fuel for power generation in Malaysia. The experiment will be conducted in order to analyze and determine the vital properties in the mixture of ethanol and gasoline mixture.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, all relevant information regarding renewable energy, non-renewable energy and the vital physical element in the blend of ethanol and gasoline are discussed. These include the information extracted from previous studies which had been conducted by other researchers. The information sources are mainly derived from journals, books, electronic article (website) and etc.

2.2 Energy demand in Malaysia

The world in the 21st century presents many critical challenges. One of the most important challenges is the environment. As population increases and the standard of living improve, there is a growing concern that there will be a shortage of energy to heat our homes and power the vehicles on which so heavily depend. Besides that, human also needs clean air, clean water, cleaner burning fuels, biodegradable and renewable materials. In this modern era, high technology has allowed the development of alternative energy sources.

Alternative energy sources are renewable, cleaner and more dependable than traditional fuels. Power generation in Malaysia both used renewable energy and non-renewable energy. However, non-renewable energy still dominated obviously. Renewable energy derives from hydropower, wind and solar energy whereas non-renewable energy is from oil, natural gas and coal (Sopian et al., 2005). Malaysia oil is estimated to last for another 19 years meanwhile the natural gas is estimated to last for another 33 years (Selamat and Abidin, 2010).

2.3 Fossil Fuel

Fossil fuels are non-renewable energy sources that formed more than 300 million years ago during the carboniferous period. Today, most of the energy that we consume for our daily applications is produced from fossil fuels, mainly derived from petroleum, natural gas and coal. Oil was formed the remains animals and plants in a marine environment. When plants and animals died, their bodies decomposed and were buried under layers of earth, sand and silt. High temperature and high pressure from these layers helped the remains turn into crude oils (Mohd. Omar Abdullah, 2012)

2.3.1 Petroleum

Basically, the word "petroleum" means "rock oil" or "oil from the earth." Petroleum is a complex mixture of hydrocarbons which may be gas, liquid or solid. It is better known as "oil" where depending on its own unique composition and the pressure and temperature at which it is confined (Gatlin C., 1960). Base designation